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by further light on the molecular changes underlying attention fatigue. This relation will put us a step nearer discovering the physiological basis of one metaphysical concept.

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REVIEWS AND ABSTRACTS OF LITERATURE

Plant Breeding. Comments on the experiments of Nilsson and Burbank. HUGO DEVRIES. Chicago and London: The Open Court Publishing Co. Pp. vi + 360.

This work of deVries's is primarily devoted to an exposition of the methods followed by Nilsson and Burbank, but of equal importance and interest is the attention that is given to his theory of evolution and mutations.

The work of Nilsson, which will revolutionize plant breeding and open fields of scientific investigation of fundamental importance, has heretofore been concealed from the public owing to the fact that he has entirely disregarded all educational aims and purely scientific researches. His sole effort has been directed to the amelioration of agricultural crops, but it should be added that his work is based upon the most exact and scientific methods. This report of deVries's will bring amazement when it is learned that in the little Swedish village of Svalöf, opposite Copenhagen in Denmark, results have been obtained and principles have been discovered during the past fifteen years which exceed in importance all the achievements in agricultural history.

This work was started owing to the slow but manifest deterioration of various agricultural crops, which lessened the value of the harvests in an important degree. A few Swedish farmers formed a company in 1886 at Svalöf for the purpose of procuring and testing new foreign varieties of seeds in order to replace the inferior Swedish varieties. Naturally, the German method, which was most widely practised at that time, of improving the quality of the grain, was followed. The practise was to select numerous examples of the best specimens of a particular crop, *i. e.,* make a "multiple selection," and this *élite* stock was sown, and similar selections were again made from it. Year after year the best examples were chosen from the successive crops, and slowly and gradually the qualities were supposed to improve in the direction desired. While important additions were made by this method to several varieties of grains during the early history of the company, a more important fact became obvious, that success was the exception, and it soon became a demonstration that the old idea of the arbitrary control of the qualities of a plant was manifestly untrue. It became evident that the plant develops after its own nature and can not be forced into other ways.

It was at about this period in the history of the work (1890) that

Nilsson became director. His thorough knowledge of the laws of variability and inheritance led him early in his work to the remarkable discovery that each so-called variety of grain really embraced a protean group of types, that is, each cultivated species was made up of numerous elementary species. Five hundred such species have been separated from the common peas, and all the cereals were found to contain several hundred. So the first problem in plant breeding was not the multiple selection of the German method, which would in all probability result in associating numerous elementary species, but rather the selection of a particular plant or elementary species. With this idea in mind about two thousand divergent types were gathered, in 1892, and the grains from each mother plant were sown in separate plots. The results exceeded all expectations. Barring chance hybrids and mutants, all the plots showed offspring of exceptional uniformity. For example, of 422 plots of oats 397 were uniform and only 25 were multiple. Furthermore, an examination of the pure types, in 1893, showed that their mutual differences were much greater than could have been surmised from the amount of variability in the field at the time of the selection. More important still, these types were found to comply with the most diverse requirements, some were highly resistant to frosts, others to disease, some were suited for hard land, and others for light soil; they differed in stiffness of culms, length of ears, size and number of grains, etc. In a word, hardly any demand could be pointed out which at least one of the new varieties did not meet.

Scarcely less important than this remarkable discovery was Nilsson's methodical study of the association of plant characters. While the relationship between the morphological characters of the plant and its qualities has been recognized in a degree for a long time (indeed, this is the basis of practically all of Burbank's work), it remained for the Svalöf station to demonstrate the intimate relation or correlation between plant characters and qualities—a principle of the greatest practical value. As soon as it was established that any field of grain contains a great many types so widely variable as to furnish suitable stock for the most different conditions, the need was felt for a method to enable the breeder to make the desired selection. Study along this line showed that numerous apparently insignificant characters remained fairly consistent in the successive sowings, and so offered a reliable means of distinguishing strains of widely divergent practical value. The problem then was to classify these characters and correlate them with their agricultural qualities. A compilation was begun, and a system has slowly been elaborated for many of the cereals, peas, vetches, etc., so that when a particular quality is desired in any of these plants in order to bring it into a form suitable for other conditions of soil or climate, or to comply with any want of the breeder, it is only necessary to know the marks associated with the desired quality in order to select a stock that will meet the required demands. In a word, these studies demonstrated that there is a regular coincidence of characters which hitherto have been regarded as quite independent from one another. Furthermore, this association of characters was shown to obey natural laws, and a study of these laws enabled the breeder to predict a quality from the observation of one or several characters. The result of the work of the station is seen in the rapid improvement of the crops and in the certainty and directness of the results obtained. Thus in 1901 eighteen excellent new types were made available, a sharp contrast to the German method where twenty years of the most careful selection were well spent if a single new form was secured.

DeVries has made full use of this work in fortifying his mutation theory. Owing to the elaborate system of bookkeeping, every quality and character of a variety was recorded. As a consequence any deviation in the offspring from the mother plant became manifest at its first appearance. The records of the station show that several variations appeared from time to time that correspond with deVries's idea of a mutant. They always appeared suddenly, they could be separated from the other plants in the same way as the elementary species, and they were constant in the transmission of their new characters. But of much more importance to deVries is the light that this work throws upon the work of Rimpau and other breeders, who by years of careful breeding gradually so ameliorated the races of rye and other cereals (so they believed) as to produce a highly superior variety. Darwin was greatly influenced by this commonly accepted belief of breeders and applied it to his views on evolution, assuming that similar gradual changes went on in nature, and so led to the slow creation of species by a gradual, imperceptible series of changes. The so-called creation of new varieties by breeding has been a serious argument against the mutation theory and one that it has been impossible to answer until the results of Nilsson and other workers were available. It can not be questioned that the old breeders achieved success by a chance separation of a pure stock after years of haphazard selection. The work of Svalöf demonstrates that but a single initial selection of an elementary species is necessary, and it only remains to multiply and test the exact value and worth of the form by breeding it for a few years. Any further selections are of no avail in modifying the qualities of the selected species. We regret that the author has not discussed the continuous variations of these mutants; possibly the records of the station do not furnish, as yet, the necessary data upon this point. The main contention regarding the validity of the mutation theory is now reduced to this, Do the curves of continuous variation of the parent and mutant overlap? If not, deVries has established his theory; if they do, he has yet to prove that the mutant is not an extreme of continuous variation.

While much false and misleading information has been published regarding the work of Burbank, sufficient fairly accurate accounts of his accomplishments have been written to make his methods and achievements familiar to all. Mr. Burbank is an idealist; he is not concerned with the purely scientific aspects of horticulture, but is actuated solely by a desire to contribute to the welfare of his fellow men. No better measure of the man could be given than his dream of developing a spineless cactus that by its adaptability to arid conditions and its edible qualities would make possible the doubling of the population of the world. He has no desire to accumulate wealth; as soon as his novelties are proven fit they are sold and their propagation and distribution is left to dealers. Thus it was with his first hybrid, in 1873—the Burbank potato. This was sold to a seed firm in 1875 for $125. The Department of Agriculture a few years ago estimated that this potato had added to the agricultural productivity of the country $17,000,000. It is safe to state that these figures will appear of little moment when as long a period has been given for the introduction of his recently derived berries, plums, walnuts, etc.

Mr. Burbank is little concerned with the amelioration of a race, and in this respect his work is quite different from that of the Svalöf station. His results in plant breeding have largely been obtained by hybridizing. Crossing of plants upsets the constancy of the species, brings them into a state of unstable equilibrium, and produces a chaos of forms. From these forms any of value are selected. Thus his methods have been perfected along the lines that have been followed since the beginnings of horticultural practise. Burbank, however, excels all other breeders in two respects. He starts with as many promising species as possible. Thus in his callas, five new types were added at once by a series of crossings with the familiar white kind; so also with his improvement of the California tiger lily, many of the lilies of the world have contributed their peculiarities for the enrichment of the native form. An idea of the extent of the material with which he works may be gained from the fact that he has had under cultivation 2,500 distinct species.

It is commonly believed that these improved forms are new creations. Hybridizing introduces into the offspring a new association of characters. No new characters are added. Every novelty has its basis in some previously existing form. The stoneless prune was derived from numerous crossings of a worthless French prune, *prune sans noyau,* with the ordinary varieties. This stoneless prune was known two centuries ago and had since been cultivated as a curiosity. Burbank saw the possibilities in associating its stoneless character with the flavors, colors, and meat of other forms. Crossings and selections have already isolated one stoneless form for the trade, with prospects that all the present varieties will finally be blended with the stoneless trait.

Mention can only be made of the excellent résumé of the mutation theory and of the important discussion to American farmers of corn breeding. Several features in the closing chapters on plant distribution will be taken with more or less reservation by many. The discussion of the principles of adaptation, however, are most timely. He very justly characterizes the attempts to explain the larger groups of characters of organisms as the expression of relationship with special features of the environment as "merely poetical descriptions of the way in which we should like to understand and admire nature." We can not refrain from noting that the author occasionally drops into the realm of poetry, as when he refers to plants remaining on the mountains owing to their dread of enemies in the valley (p. 340), or when he speaks of plants seeking conditions (p. 335).

This book is one of the most valuable contributions to botanical science that has appeared in recent years. It will be widely read because of the clear scientific discussion of the principles that underlie plant breeding.

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A Primer of Psychology. LAURA BRACKENBURY. London: John Murray. 1907. Pp. 120.

The author expresses, in her preface, her special indebtedness to Professors Ward, Stout, and Johnson, of Cambridge University, and Professor James, of Harvard. Her technical point of view will be fairly familiar to those who have read the first two writers mentioned. An introduction gives some timely suggestions to the beginning student. Then the various methods of psychological study are presented and evaluated; it is maintained that the direct method must have logical and temporal priority. Next comes the "general analysis of mind," in which the *a priori* concept of the subject-object relation is made fundamental and its three phases are used to define the three classes of mental phenomena—cognition, affection (including pleasure-pain and appetition-aversion), and attention, or activity. There follow four chapters on the several stages of cognition: sensation, perception, imagination, and ideation. The subject of cognition is given quite half the space of the text, but its divisions, sensation and perception, are given relatively brief treatment, the usual details on their special modes and forms being omitted. The more fundamental laws of mental complication and unification are developed under perception and imagination; conditions of origin and growth of higher forms receive some attention; and the function of the universal and of the word is not omitted. Attention is viewed as activity of varying degrees, not as mere focalization. The discussion of how pleasure-pain is conditioned by each of the four stages of cognition is along quite traditional lines, physiological explanations being omitted. One of the most successful chapters in the book is that in which James's theory of emotion is described and criticized; emotion is found to contain an ideational factor. Will as selective action has its root in impulse; a good analysis of an act of will is given.

Following the text is a glossary which is rather unsatisfactory; for it is often formal to the point of emptiness, or its definitions fail really to define (*e. g.*, affection, ideation, mind). Then come some questions and exercises. These (especially the general questions in preference to those arranged by chapters) will be useful alike to teachers and students; and particularly those questions (of which there is a good proportion) that